ADVANTAGES IN THE NONUNIFORM HOUR OF OBSERVATION IN THE INTERPRETATION OF PUBLISHED PRECIPITATION DATA

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Hydrologists in their work must continually refer to rainfall records. Perhaps those most readily available, and hence most often used, are the published records of the cooperative and first-order stations of the Weather Bureau. The greater portion of these stations are maintained by unpaid volunteers, and the records of these cooperative stations are the foundation for most hydrologic studies.

The records, as prepared by the observer, include, among other data, the depth of precipitation in the 24 hours preceding the hour of observation, and in most instances the times of beginning and ending of each period of actual rainfall. In addition, those of the first-order stations show hourly depths. The published records of precipitation, however, show only the 24-hour depths and the time of observation. Since cooperative observers take observations at a time convenient to themselves, it follows that the hour is not uniform for all stations, but, in general, they fall into two groups: those taken in the evening near sunset, and those taken in the morning shortly after sunrise. Exceptions to the above, however, are frequently noted, as, for example, the first-order stations, whose rainfall records indicate the midnight-to-midnight depths, and the river-rainfall stations, whose records usually indicate the precipitation in the 24 hours previous to 7 or 8 o'clock in the morning. This variation among the several stations is permitted by the Weather Bureau so long as the hour of observation is the same each day at a given station.

The cooperative observer records the observed data for each daily observation on a monthly record form in triplicate. The original sheets are on file at the various climatological section centers, the first carbon copy is bound and on file in the Central Office of the Weather Bureau, and the second carbon copy is retained by the observer himself. Similarly, disposition of the original record sheets of all other types of stations is such that they are not usually convenient to the hydrologist who may need the data on the more exact distribution of rainfall (times of beginning and ending, etc.); the various original records are the only sources of these data, and it may be inconvenient and expensive for him to consult them directly, hence the less detailed but more readily available published data must, in most instances, be the foundation for his studies.

It is usually true, however, that the hydrologist need not know the times of beginning and ending to the exact minute, or even the exact hour. If he knew, for example, that a 3-inch rain fell in the interval between sunset and midnight of a given day rather than from sunset of that day to sunset of the next day (as would be inferred from the record of a p. m. station), the record would be considerably enhanced and, for many hydrologic problems, sufficiently detailed.

The following discussion is intended as an aid in interpreting the published data, so that useful and more accurate approximations of rainfall intervals may be determined. It will be shown that the above-mentioned variation in the hour of observation between stations is an aid rather than a hindrance to the hydrologist under the present method of publication. While not so satisfactory as having access to the times of beginning and ending, it is nevertheless quite often possible by this method to determine the portion of a day in which the rain began or ended.

The stations whose data are used as examples in this discussion are listed in table 1. The classification (a. m. station, p. m. station, or midnight station) of each has reference to the approximate time of observation, and they will be referred to as such.

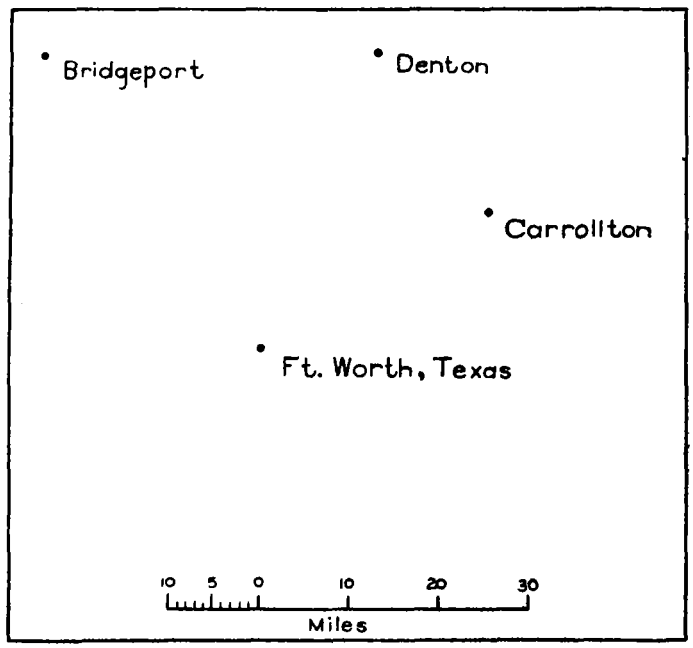

FIGURE 1.

TABLE 1

Name	Classification	Time of observation
Bridgeport	A. m. station	After sunrise, probably 7 or 8 o'clock a. m.
Carrollton	A. m. station	After sunrise, probably 7 or 8 o'clock a. m.
Denton	P. m. station	Near sunset, probably 5 or 6 o'clock p. m.
Fort Worth	Midnight station	Has a recording rain gage but published daily totals reflect amount of precipitation in the 24 hours from midnight to midnight of the day for which precipitation is shown.

These stations are all in the Trinity River Basin, in eastern Texas. As shown by the following map (fig. 1), they are considered to be in sufficient proximity to each other to justify their use as examples in this discussion and to validate the soundness of the conclusions drawn.

In the following examples, all data are from the printed volume "Climatological Data, Texas Section, Monthly and Annual Summaries, 1930 to 1936," a publication of the United States Weather Bureau.

Examples 1, 2, and 3 represent short storm durations, with the data for the various stations so placed that, by a proper interpretation, one may determine the one-third part of the day in which the total storm occurred, i. e., midnight to a. m. (example 1), a. m. to p. m. (example 2), or p. m. to midnight (example 3).

Example 4 was selected to show how the data from

surrounding stations may be an aid to the hydrologist in interpreting the published data for a storm which occurred at a station during all or part of two or more successive observation days.

Example 1

Station	Hour of observation	August 1933		
		14th	15th	16th
Bridgeport	A. m.	0	0.67	0
Fort Worth	Midnight	0	1.26	0
Denton	P. m.	0	1.18	0

From the Bridgeport record alone one may conclude only that the storm occurred at some time in the 24-hour interval between sunrise on the 14th and the corresponding hour on the 15th. However, a comparison of this record with the Fort Worth record indicates it began after midnight of the 14th–15th. Therefore, the entire storm must have occurred in the interval 12 midnight (14–15) to after sunrise of the 15th.

Example 2

Station	Hour of observation	5th	6th	January 1935		9th
				7th	8th	
Carrollton	A. m.	0	0	T	0.40	0
Fort Worth	Midnight	0	T	0.42	0	0
Denton		0	0	.54	0	0

From the Denton record one may conclude that the rain ended by the evening of the 7th, while the Carrollton record indicates the rain began after sunrise of the 7th. Hence we may conclude that the storm interval was between sunrise and sunset of the 7th.

Example 3

Station	Hour of observation	4th	June 1930		7th
			5th	6th	
Bridgeport	A. m.	0	0	.25	0
Fort Worth	Midnight	0	.55	0	0
Denton	Sunset	0	0	.52	0

In this storm it is noted that the rain ceased by midnight of the 5th–6th, because Fort Worth recorded none after that time. It must have started raining after sunset of the 5th, because Denton had received none before that time. Hence we may conclude that it fell in the interval between sunset of the 5th and midnight of the 5th–6th.

Example 4

Station	Hour of observation	March 1933			
		4th	5th	6th	7th
Bridgeport	A. m.	0	0.81	1.02	0
Fort Worth	Midnight	0	1.60	0	0
Denton	P. m.	0	1.93	0	0

From the Bridgeport record it is evident that the rain fell some time in the 48 hours from after sunrise on the 4th to after sunrise on the 6th. However, comparison with the Fort Worth record indicates that the interval was 24 hours or less, and confined between midnight of the 4th–5th, and midnight of the 5th–6th.

Now, the Denton record indicates that the precipitation must have ceased previous to sunset of the 5th. Thus we have shortened the maximum-possible storm period of 48 hours to a maximum-probable period of 18 hours between midnight of the 4th–5th and sunset of the 5th.

The data in example 4 are now considered with the purpose of constructing a mass curve of precipitation for the station at Bridgeport.

Curve ADG (fig. 2) may be considered the limiting mass curve of precipitation if data for the Bridgeport station alone were available. However, the nearby a. m. station at Denton had received no rain before observation

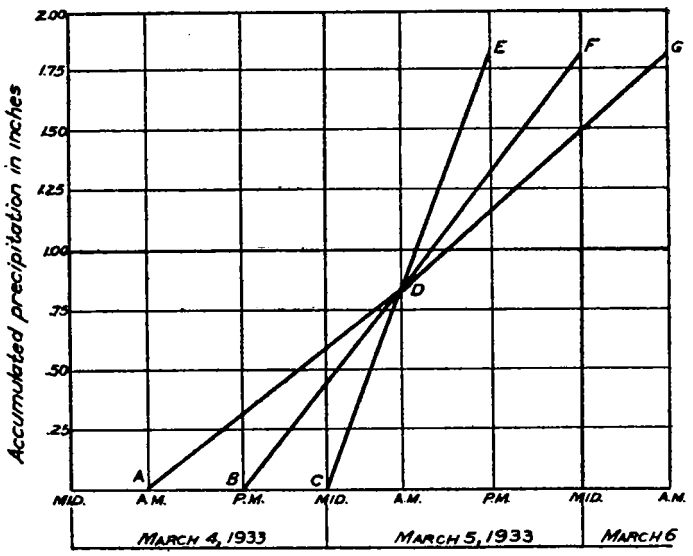

FIGURE 2.

time on the 4th, and the compatibility of the two records justifies the inference that the reach BD is preferable to AD. Similarly, the record for the midnight station at Fort Worth indicates that there had been no rain at that station before midnight of the 4th–5th, and so it follows that CD is the more nearly correct reach than either AD or BD.

Reach DG is superseded by DF when one considers the fact that Fort Worth shows no rain after midnight of the 5th–6th; and the p. m. station at Denton shows no rain to have fallen after its observation time on the 5th, thus further restricting the period of rainfall, and giving preference to the reach DE rather than either DF or DG.

The final limiting mass curve CDE is obviously to be preferred to the curve ADG and is probably the best that can be drawn from the data at hand.

CONCLUSION

By a juxtaposition of the 24-hour precipitation records of nearby stations of varying times of observation, the maximum probable period of precipitation for a given storm will, in many cases, be considerably shorter than that possible to be determined if all stations took observations at a uniform hour.